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File-transfer servers carry big loads between LANs

Large collections of data move efficiently from one local network to another, keeping distant offices closely linked.

By transferring text, program, and data files between work stations, local-area networks provide such automated services as data sharing, communications, and distributed processing within the office. The next step is to supply such services on an interoffice basis, by transferring files between different networks or between remote mainframes and local networks. But whereas the buffered packet-switching gateways normally used between work stations are suitable for real-time exchanges of brief messages, they will prove inefficient for internetwork transfers of larger collections of data. A more effective solution is specially programmed microcomputers called file-transfer servers.

Packet-switching gateways transfer uninterpreted packets of bits, with no particular relationship necessary or recognized between packets and with no memory of previous operations. File-transfer servers, on the other hand, can recognize and manipulate whole, related collections of data compatible with high-level operating systems.

Most local-area networks built around microcomputers assign certain stations to the performance of specific network tasks (Fig. 1). For example, to allow users to share expensive peripherals, such as hard disks, all commands to access hard-disk data are addressed to a station assigned to be a network file server. This microcomputer is the only machine that directly accesses data on the mass-storage devices in question.

User work stations often communicate with server stations by creating request files that are stored on shared hard disks. For example, work stations sharing printers execute print-request software and create print requests via a file server (Fig. 2). A microcomputer assigned to be a print server runs under applications software that allows the microcomputer to control multiple printers.

Print-request programs, run by the users, not only create print requests but also store them on system hard disks. The print server, via a network file server, reads these requests and fills them. Print-request files include such parameters as files to be printed, where on hard disks the files are to be found, printer setup (forms, ribbon, etc.) to be used, number of copies, page length, and page title.

One or two file-server and print-server stations are usually sufficient to handle the needs of 30 or 40 user work stations on a given network.

Gateway servers can help

Should a user wish to communicate with a file server on another network, he may address his network file-server commands to a gateway server on his own network (Fig. 3). This machine, connected to both networks, functions as a real-time buffered packet repeater, relaying user keyboard information and requests from one network to another.

If a user wishes to transfer text, data, or program files to or from storage devices on another network, the transfer command may be sent to a server station assigned to file-transfer activities. If the file-transfer server is connected to both networks, it can accomplish all requested transfers by itself. If the second network is remote, the first file-transfer server may be connected via a modem or other communications link to the second one.

Server work stations are software-intensive. In fact, network performance, often presented in terms of hardware and compatible operating systems, is quite sensitive to such server work station software, and may be degraded if it is poorly written.

In a typical implementation, user and server stations bootstrap according to a hierarchy of start-up files (both text and program) stored on shared system disks (Fig. 4). Each type station maintains a set of virtual volumes in the shared memory; these are formatted to look like floppy disks and contain the stations' current operating systems, start-up files, data, text, and programs.

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At power-on, the station automatically bootstraps from a ROM chip within it, and reads its network profile file. This file contains the name of the station's boot volume, whether the volume is to be bootstrapped automatically or not, access rights to be set for the station's volumes, the names of any shared network library volumes, and the station's name.

Next, any start-up commands on the station's bootstrap volume are read and executed. These commands will specify which portions of the network's mass storage are to be made automatically accessible and which application programs are to be loaded and executed.

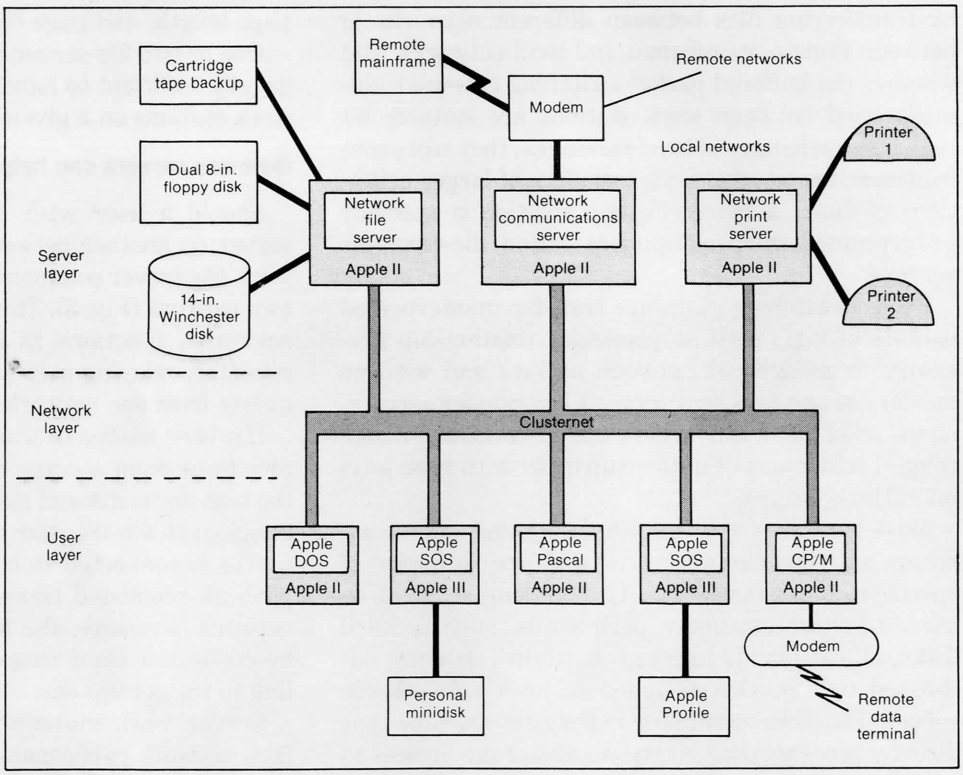
In turnkey applications, consequently, the user need only turn on the work station. Automatic bootstrapping, profiling, and start-up files then configure the station automatically, setting system defaults and bringing the appropriate application prompting messages onto the screen.

Programs for server stations are loaded and run automatically in the same way. Command files and configuration commands within the program set the system parameters that determine the schedule of server activities (for example, how often electronic mail will be forwarded to a remote network).

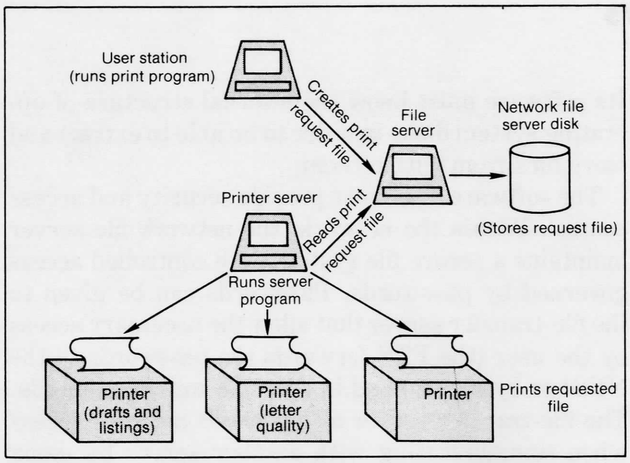
File-transfer servers run in two modes, which may overlap: a periodic, scheduled mode controlled by command files and time-ordered command queues; and a demand-transfer mode controlled by real-time user input of commands and schedules (Fig. 5).

In the scheduled mode, the program, using a network clock-calendar, checks shared memory for files (via the file servers) to be moved to other shared storage devices either on the same network or another network or to any CPU on those networks. Schedules, source and target locations, and files to be transferred are all specified in parameter text files and command text files on the FTS bootstrap software.

Scheduled actions of the file-transfer server can also be initiated by incoming signals from other CPUs, including other file-transfer servers. For example, a



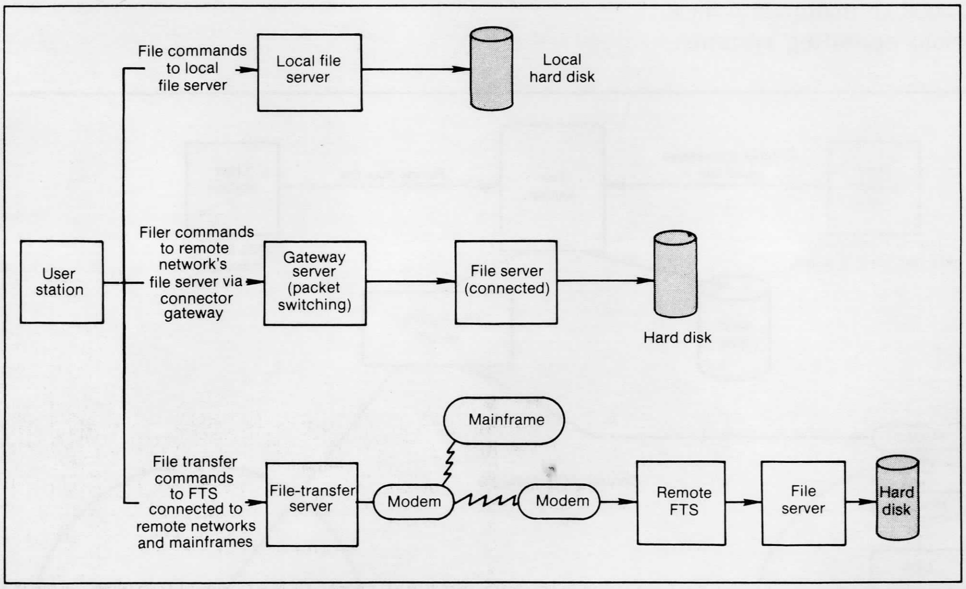
1. In the Cluster One system, 8-bit microcomputers act as user work stations or network server stations. Moreover, internetwork and mainframe connections are made using 8-bit microcomputers assigned as packet-switching and file-transfer communications servers. In addition, each personal computer works independently, and network topology can be star, tree, daisy-chain, or common-bus.



2. Request files stored on shared memory often mediate user-server transactions. Here, a microcomputer assigned to be a print server runs under application software that allows it to control multiple printers. Users create print requests that are stored on system hard disks. The print server, via a network file server, reads these requests and fills them.

branch office may wish to send sales data to the company's main office at the end of each day. Time of transfer and data to be transferred are specified in a command file. The transfer will then occur automatically at the scheduled time each evening, taking advantage of nighttime transmission rates. Should the branch network turn out to be one desktop microcomputer without a clock card, the file-transfer server in the main office can initiate the call and transfer.

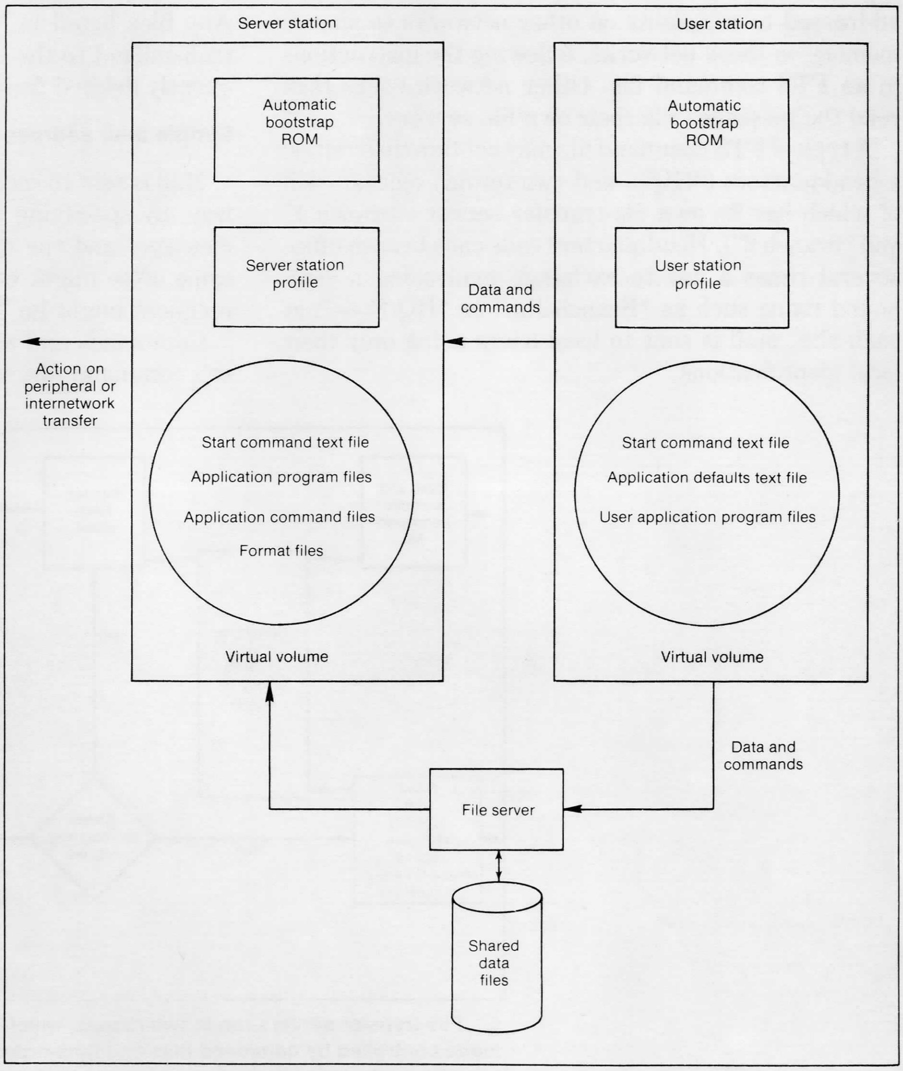
In the demand-transfer mode, the file-transfer server checks for and reacts to incoming signals from network users. In this mode, one-time-only commands will be executed either at a specified time or over a specified interval, using parameters input by the user. These parameters will supersede any defaults of the FTS set via text files in its bootstrap software. This mode may be used in the same way as the print server facilities shown in Fig. 2—via request files created and stored on shared memory or via network commands addressed directly to the file-transfer server.


User station
File commands to local file server
Local file server
Local hard disk
Filer commands to remote network's file server via connector gateway
Gateway server (packet switching)
File server (connected)
Hard disk
File transfer commands to FTS connected to remote networks and mainframes
File-transfer server
Mainframe
Modem
Modem
Remote FTS
File server
Hard disk

3. Data and program files on a local network are accessed via a microcomputer assigned to be a network file server. Real-time, buffered packet-switching with other networks and mainframes occurs using a microcomputer assigned to be a gateway server. A file-transfer server is used to move files between networks and to or from mainframes.

Say a branch office needs to obtain new product data from the main office immediately. A request is addressed to the file-transfer server, which passes it along to the main office. The required product information can be returned in the same way. Remote communications are available through dial-up, leased, and hard-wired communications circuits. In either mode, the FTS acts as a compiler and executer, keeping a time-ordered queue of commands to execute (Fig. 5). The two modes may overlap if, for example, a user issues a request that requires scheduled operations.

In today's corporate world, mainframes own the data, and local-area networks frequently serve as data-analysis tools and adjuncts to the mainframes. In such systems, central mainframes and their connected local-area networks also provide support for branch-office local-area networks. These distributed branch networks receive administrative and product information daily from the central site and return sales and inventory information.



4. User and server microcomputers run under network-application software. A nested series of start-up bootstrap programs allows fully secure turnkey systems. User data and network commands are accepted by server stations after automatic start-up.

One form of branch-office support is internetwork electronic mail (Fig. 6). A user can create and send a message by executing specialized software that, when prompted, specifies the recipients of the mail, the subject of the message, and the body of the message. The mail program instructs a network file server to create a message file with the recipient's name on it. Recipients within the same network, also executing the mail program, instruct their file server to read any messages for them that currently reside in shared memory. The file-transfer server then moves messages addressed to recipients on other networks to shared memory on those networks, following the instructions in an FTS command file. Other network users then read the messages via their own file servers.

A typical FTS command file may contain three sites: a headquarters ("HQ"), and two branch offices, each of which has its own file-transfer server ("branch 1" and "branch 2"). Headquarters calls each branch office several times a day to exchange mail using a compound name such as "Branch/Jim" or "HQ/Boss"; at each site, mail is sent to local users using only their local identifications.

The FTS command file first defines all the sites that will be involved in file transfers. The sites are named (e.g., "branch 1") and, when necessary, site telephone numbers are given. Next, the names of the files to be received are specified, together with the local hard-disk directory they are to be listed in when received.

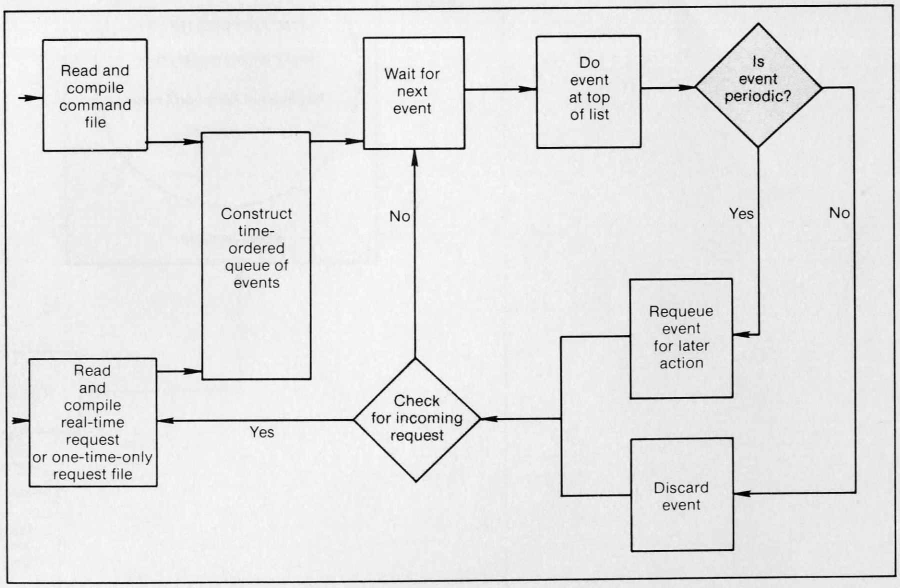
Regularly scheduled tasks are defined in the command file by listing commands that the file-transfer server compiles, creating an internal data structure.

Say two tasks are defined—every four hours, the FTS work station, via modems, will call two sites. Any files listed in "mail/branch 1" will be read and transmitted to the branch FTS machines and subsequently deleted from the local hard disk.

Simple mail addressing

Mail is sent to recipients on all networks in the same way: by specifying the recipients, the subject of the message, and the message itself. A recipient in the same office might be "Smith." In a branch office, the recipient might be "Branch/Jones."

Commands and schedules in the file-transfer server's command file, which constitute the system's de-


Read and compile command file
Construct time-ordered queue of events
Wait for next event
Do event at top of list
Is event periodic?
Yes
No
Requeue event for later action
Discard event
No
Check for incoming request
Yes
Read and compile real-time request or one-time-only request file

5. File-transfer servers run in two modes, which may overlap: a periodic, sheduled mode controlled by command files and time-ordered command queues; and a demand-transfer mode controlled by real-time user input of commands and schedules.

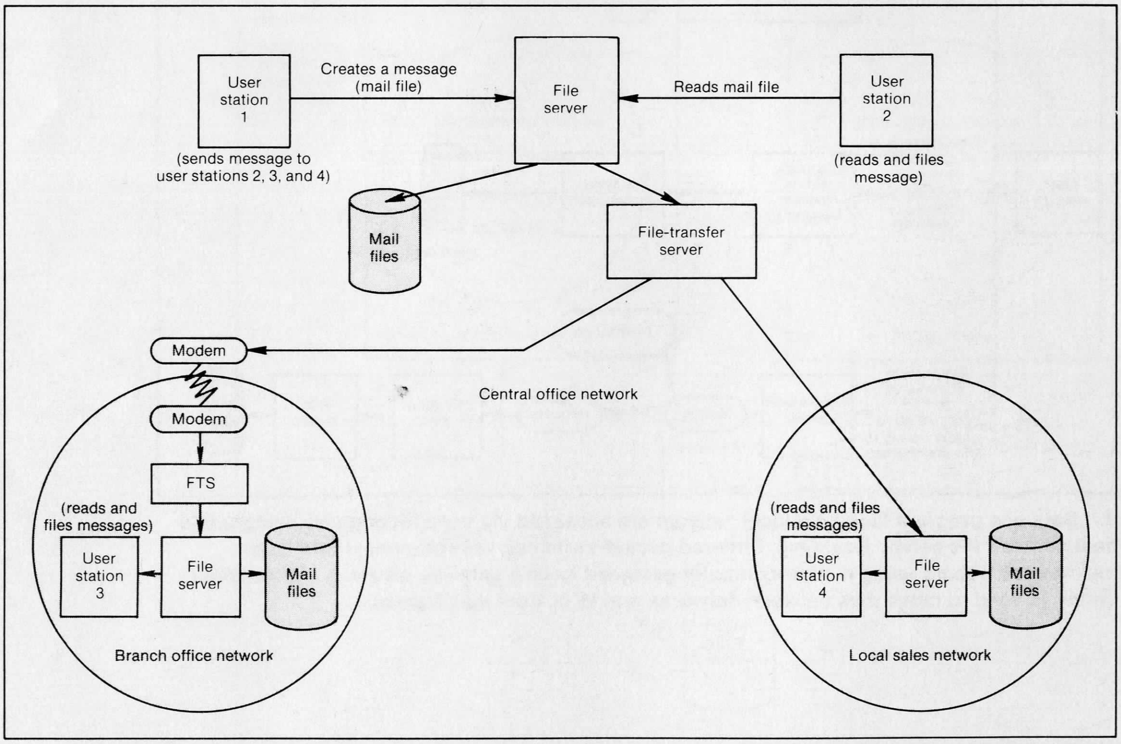
fault parameters, may be overridden by direct user transmissions to the FTS station, or by an FTS discovery of a set of request-for-service files that previously have been created by users on the network's shared hard disks.

In general, software for a file-transfer server is not particularly sensitive to the language in which it is written, although the low-level network access drivers and the drivers for communication-line access should be written in low-level language. Otherwise, the software need only be compatible with the operating system under which the server is running.

It is important, however, that the file-transfer server understand all network protocols for naming files. In the case of the Cluster One system, file naming is hierarchical, so that the file-transfer server can manipulate complete trees and subtrees of network file server files with one command.

In addition, the FTS will need to manipulate files formatted for use within various operating systems. Its software must know the internal structure of operating system disks in order to be able to extract and move files from within them.

The software also must provide security and access control. Within the network, the network file server maintains a secure file system with controlled access governed by passwords. Passwords can be given to the file-transfer server that allow the necessary access by the user (the FTS forwards the passwords to the NFS) or by a command in the FTS initialization file. The file-transfer server also controls network access when communicating with another server by using passwords of its own. External access to the network is subject to this added security and control.□



6. Internetwork electronic mail is one form of branch office support. With the Messenger, messages created on the central network are stored by a network file server on a shared disk. File-transfer servers move these stored messages on a periodic, scheduled basis to branch networks via dial-up, leased, or hard-wired communications circuits. Corporate data is moved similarly.

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